

WHAT IS CLAIMED IS:

1. A zoom lens comprising:
 - a first group optical system having a positive refracting power;
 - a second group optical system having a negative refracting
 - 5 power;
 - a third group optical system having a positive refracting power;
 - and
 - a diaphragm that moves toward an object side integrally with the
 - third group optical system, wherein
 - 10 the first group optical system, the second group optical system,
 - and the third group optical system are sequentially arranged from the
 - object side toward an image side,
 - at least the first group optical system and the third group optical
 - system moves in such a manner that a distance between the first group
 - 15 optical system and the second group optical system becomes minimum
 - at a short focal-length side, and a distance between the second group
 - optical system and the third group optical system becomes minimum at
 - a long focal-length side, and
 - the third group optical system includes a triplet lens formed by
 - 20 sequentially bonding a negative lens, a positive lens, and a negative
 - lens.
2. The zoom lens according to claim 1, wherein a trace of a
- movement of the first group optical system between the short
- 25 focal-length side and the long focal-length side makes a convex shape

opening to the object side.

3. The zoom lens according to claim 2, wherein the first group optical system is closest to the image side at a mean focal-length side
5 between the short focal-length side and the long focal-length side.

4. The zoom lens according to claim 1, wherein the negative lens, closest to the object side, of the triplet lens is formed with a strong concave opening to the image side.

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5. The zoom lens according to claim 1, satisfying a relation
$$0.6 < K_{12} / (f_w + f_t) < 1.2$$
where K_{12} is changing amount of a distance between the first group optical system and the second group optical system, f_w is a combined
15 focal length of whole system at the short focal-length side, and f_t is a combined focal length of the whole system at the long focal-length side.

6. The zoom lens according to claim 1, satisfying relations
$$-0.22 < N_p - N_n < 0 \text{ and } 3 < v_p - v_n < 36$$
where N_p and v_p are a refractive index and an Abbe constant of the
20 positive lens of the triplet lens, respectively, and N_n and v_n are an average of refractive indexes and an average of Abbe constants of the two negative lenses of the triplet lens.

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7. The zoom lens according to claim 1, wherein the third group optical system further includes at least one positive lens at each of the object side and the image side of the triplet lens.
- 5 8. The zoom lens according to claim 7, wherein at least one positive lens from among the positive lenses arranged at the object side and the image side of the triplet lens is an aspheric lens.
9. The zoom lens according to claim 1, wherein each of the first
10 group optical system and the second group optical system includes at least one positive lens and one negative lens.
10. A zoom lens comprising:
a first group optical system that has a positive refracting power
15 and does not move with zooming;
a second group optical system that has a negative refracting power and moves from an object side toward an image side with zooming from wide-angle side toward telephoto side;
a third group optical system that has a positive refracting power
20 and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and
a fourth group optical system that has a positive refracting power and does not move with zooming, wherein
the first group optical system, the second group optical system,
25 the third group optical system, and the fourth group optical system are

sequentially arranged from the object side toward an image side, and
the third group optical system includes a triplet lens formed by
sequentially bonding a negative lens, a positive lens, and a negative
lens.

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11. The zoom lens according to claim 10, wherein the negative lens,
closest to the object side, of the triplet lens is a negative meniscus lens
having a meniscus shape with a concave opening to the image side.

10 12. The zoom lens according to claim 10, wherein the negative lens,
closest to the image side, of the triplet lens is a negative lens with a
concave opening to the image side.

13. The zoom lens according to claim 10, satisfying relations
15 $1.45 < N_{c2} < 1.52$ and $68 < v_{c2} < 85$
where N_{c2} and v_{c2} are a refractive index and an Abbe constant of the
positive lens arranged in the middle of the triplet lens, respectively.

14. The zoom lens according to claim 13, satisfying relations
20 $1.60 < N_{c1} < 1.95$,
 $20 < v_{c1} < 40$,
 $1.60 < N_{c3} < 1.95$, and
 $20 < v_{c3} < 40$

where N_{c1} and v_{c1} are the refractive index and the Abbe constant of the
25 negative, closest to the object side, of the triplet lens, respectively, and

N_{c3} and v_{c3} are the refractive index and the Abbe constant of the negative lens, closest to the image side, of the triplet lens, respectively.

15. The zoom lens according to claim 10, satisfying a relation

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$$0.25 < (R_{c2}/R_{c4}) < 1.25$$

where R_{c2} , and R_{c4} are radiuses of curvatures on the object side and the image side of bonding surface of the triplet lens, respectively.

16. A zoom lens comprising:

10 a first group optical system that has a positive refracting power and does not move with zooming;

a second group optical system that has a negative refracting power and moves from an object side to an image side with zooming from wide-angle side toward telephoto side;

15 a third group optical system that has a positive refracting power and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting power and does not move with zooming, wherein

20 the first group optical system, the second group optical system, the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and

the third group optical system includes

25 a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens; and

at least one positive lens at each of the object side and the image side of the triplet lens.

17. The zoom lens according to claim 16, wherein at least one
5 positive lens from among the positive lenses arranged at the object side and the image side of the triplet lens is an aspheric lens.

18. A zoom lens comprising:
a first group optical system that has a positive refracting power
10 and does not move with zooming;
a second group optical system that has a negative refracting power and moves from an object side toward an image side with zooming from wide-angle side toward telephoto side;
a third group optical system that has a positive refracting power
15 and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and
a fourth group optical system that has a positive refracting power and moves accordingly with zooming, wherein
the first group optical system, the second group optical system,
20 the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and
the third group optical system includes a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens.

19. A zoom lens comprising:
a first group optical system having a positive refracting power;
a second group optical system having a negative refracting power;
5 a third group optical system having a positive refracting power;
a fourth group optical system having a positive refracting power;
a fifth group optical system having a positive refracting power;
and
a diaphragm arranged at an object side of the third group optical
10 system, wherein
the first group optical system, the second group optical system,
the third group optical system, the fourth group optical system, and the
fifth group optical system are sequentially arranged from the object side
toward an image side,
15 at least the second group optical system and the fourth group
optical system move with zooming from short focal-length side toward
long focal-length side, and
the second group optical system includes a triplet lens formed
by sequentially bonding a negative lens, a positive lens, and a negative
20 lens from the object side.
20. The zoom lens according to claim 19, wherein the negative lens,
closest to the object side, of the triplet lens is a bi-concave lens.

21. The zoom lens according to claim 19, wherein the negative lens, closest to the image side, of the triplet lens is a bi-concave lens.

22. The zoom lens according to claim 19, satisfying relations

5 $1.70 < N_{c2} < 1.90$ and $20 < v_{c2} < 40$

where N_{c2} and v_{c2} are a refractive index and an Abbe constant of the positive lens arranged in the middle of the triplet lens, respectively.

23. The zoom lens according to claim 22, satisfying relations

10 $N_{c1} < 1.62,$

$v_{c1} > 55,$

$N_{c3} > 1.65,$ and

$v_{c3} < 40$

where N_{c1} and v_{c1} are the refractive index and the Abbe constant of the
15 negative, closest to the object side, of the triplet lens, respectively, and
 N_{c3} and v_{c3} are the refractive index and the Abbe constant of the
negative lens, closest to the image side, of the triplet lens, respectively.

24. The zoom lens according to claim 19, satisfying a relation

20 $0.2 < (R_{c2}/R_{c4}) < 0.4$

where R_{c2} , and R_{c4} are radiuses of curvatures on the object side and the image side of bonding surface of the triplet lens, respectively.

25. The zoom lens according to claim 19, wherein a surface closest to the object side in the second group optical system is aspherical.

26. A camera comprising a zoom lens as a shooting optical system,
5 wherein the zoom lens includes

a first group optical system having a positive refracting power;

a second group optical system having a negative refracting
power;

a third group optical system having a positive refracting power;

10 and

a diaphragm that moves toward an object side integrally with the
third group optical system, wherein

the first group optical system, the second group optical system,
and the third group optical system are sequentially arranged from the

15 object side toward an image side,

at least the first group optical system and the third group optical
system moves in such a manner that a distance between the first group
optical system and the second group optical system becomes minimum
at a short focal-length side, and a distance between the second group

20 optical system and the third group optical system becomes minimum at
a long focal-length side, and

the third group optical system includes a triplet lens formed by
sequentially bonding a negative lens, a positive lens, and a negative
lens.

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27. The camera according to claim 26, wherein the camera is a digital camera.

28. A camera comprising a zoom lens as a shooting optical system,
5 wherein the zoom lens includes

a first group optical system that has a positive refracting power and does not move with zooming;

a second group optical system that has a negative refracting power and moves from an object side toward an image side with
10 zooming from wide-angle side toward telephoto side;

a third group optical system that has a positive refracting power and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting
15 power and does not move with zooming, wherein

the first group optical system, the second group optical system, the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and

the third group optical system includes a triplet lens formed by
20 sequentially bonding a negative lens, a positive lens, and a negative lens.

29. The camera according to claim 28, wherein the camera is a digital camera.

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30. A camera comprising a zoom lens as a shooting optical system,
wherein the zoom lens includes

a first group optical system that has a positive refracting power
and does not move with zooming;

5 a second group optical system that has a negative refracting
power and moves from an object side to an image side with zooming
from wide-angle side toward telephoto side;

a third group optical system that has a positive refracting power
and moves from the image side to the object side with zooming from the
10 wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting
power and does not move with zooming, wherein

the first group optical system, the second group optical system,
the third group optical system, and the fourth group optical system are
15 sequentially arranged from the object side toward an image side, and

the third group optical system includes

a triplet lens formed by sequentially bonding a negative
lens, a positive lens, and a negative lens; and

at least one positive lens at each of the object side and
20 the image side of the triplet lens.

31. The camera according to claim 30, wherein the camera is a
digital camera.

32. A camera comprising a zoom lens as a shooting optical system,
wherein the zoom lens includes
- a first group optical system that has a positive refracting power
and does not move with zooming;
 - 5 a second group optical system that has a negative refracting
power and moves from an object side toward an image side with
zooming from wide-angle side toward telephoto side;
 - a third group optical system that has a positive refracting power
and moves from the image side to the object side with zooming from the
10 wide-angle side toward the telephoto side; and
 - a fourth group optical system that has a positive refracting
power and moves accordingly with zooming, wherein
 - the first group optical system, the second group optical system,
the third group optical system, and the fourth group optical system are
15 sequentially arranged from the object side toward an image side, and
 - the third group optical system includes a triplet lens formed by
sequentially bonding a negative lens, a positive lens, and a negative
lens.
- 20 33. The camera according to claim 32, wherein the camera is a
digital camera.
34. A camera comprising a zoom lens as a shooting optical system,
wherein the zoom lens includes
- 25 a first group optical system having a positive refracting power;

a second group optical system having a negative refracting power;

a third group optical system having a positive refracting power;

a fourth group optical system having a positive refracting power;

5 a fifth group optical system having a positive refracting power;

and

a diaphragm arranged at an object side of the third group optical system, wherein

the first group optical system, the second group optical system,
10 the third group optical system, the fourth group optical system, and the fifth group optical system are sequentially arranged from the object side toward an image side,

at least the second group optical system and the fourth group optical system move with zooming from short focal-length side toward
15 long focal-length side, and

the second group optical system includes a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens from the object side.

20 35. The camera according to claim 34, wherein the camera is a digital camera.

36. A mobile information terminal comprising a zoom lens as a shooting optical system for a camera unit, wherein the zoom lens
25 includes

a first group optical system having a positive refracting power;
a second group optical system having a negative refracting
power;
a third group optical system having a positive refracting power;
5 and
a diaphragm that moves toward an object side integrally with the
third group optical system, wherein
the first group optical system, the second group optical system,
and the third group optical system are sequentially arranged from the
10 object side toward an image side,
at least the first group optical system and the third group optical
system moves in such a manner that a distance between the first group
optical system and the second group optical system becomes minimum
at a short focal-length side, and a distance between the second group
15 optical system and the third group optical system becomes minimum at
a long focal-length side, and
the third group optical system includes a triplet lens formed by
sequentially bonding a negative lens, a positive lens, and a negative
lens.

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37. A mobile information terminal comprising a zoom lens as a
shooting optical system for a camera unit, wherein the zoom lens
includes
a first group optical system that has a positive refracting power
25 and does not move with zooming;

a second group optical system that has a negative refracting power and moves from an object side toward an image side with zooming from wide-angle side toward telephoto side;

a third group optical system that has a positive refracting power
5 and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting power and does not move with zooming, wherein

the first group optical system, the second group optical system,
10 the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and

the third group optical system includes a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens.

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38. A mobile information terminal comprising a zoom lens as a shooting optical system for a camera unit, wherein the zoom lens includes

a first group optical system that has a positive refracting power
20 and does not move with zooming;

a second group optical system that has a negative refracting power and moves from an object side to an image side with zooming from wide-angle side toward telephoto side;

a third group optical system that has a positive refracting power
25 and moves from the image side to the object side with zooming from the

wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting power and does not move with zooming, wherein

the first group optical system, the second group optical system,
5 the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and

the third group optical system includes

a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens; and

10 at least one positive lens at each of the object side and the image side of the triplet lens.

39. A mobile information terminal comprising a zoom lens as a shooting optical system for a camera unit, wherein the zoom lens

15 includes

a first group optical system that has a positive refracting power and does not move with zooming;

a second group optical system that has a negative refracting power and moves from an object side toward an image side with

20 zooming from wide-angle side toward telephoto side;

a third group optical system that has a positive refracting power and moves from the image side to the object side with zooming from the wide-angle side toward the telephoto side; and

a fourth group optical system that has a positive refracting
25 power and moves accordingly with zooming, wherein

the first group optical system, the second group optical system, the third group optical system, and the fourth group optical system are sequentially arranged from the object side toward an image side, and

the third group optical system includes a triplet lens formed by
5 sequentially bonding a negative lens, a positive lens, and a negative lens.

40. A mobile information terminal comprising a zoom lens as a shooting optical system for a camera unit, wherein the zoom lens
10 includes

a first group optical system having a positive refracting power;

a second group optical system having a negative refracting power;

a third group optical system having a positive refracting power;

15 a fourth group optical system having a positive refracting power;

a fifth group optical system having a positive refracting power;

and

a diaphragm arranged at an object side of the third group optical system, wherein

20 the first group optical system, the second group optical system, the third group optical system, the fourth group optical system, and the fifth group optical system are sequentially arranged from the object side toward an image side,

at least the second group optical system and the fourth group
25 optical system move with zooming from short focal-length side toward

long focal-length side, and

the second group optical system includes a triplet lens formed by sequentially bonding a negative lens, a positive lens, and a negative lens from the object side.

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